CASE REPORT

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A Tetrachloroethylene Fatality

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ABSTRACT: This case report concerns a fatal exposure to tetrachloroethylene at a dry cleaning establishment. A sensitive analytical method was developed and the distribution of the chemical in various fluids and tissues was determined. Although several fatalities from tetrachloroethylene have been reported, little previous quantitative toxicological data have been found in the literature.

KEYWORDS: toxicology, tetrachloroethylene, death

Tetrachloroethylene (perchloroethylene) is a volatile liquid used in the treatment of hookworm and as an industrial solvent in dry cleaning and degreasing operations. It is a colorless liquid with an ether-like odor and is slightly soluble in water. The compound is absorbed through the lungs and the gastrointestinal tract but is not absorbed to any great extent through the skin [*1*]. Distribution occurs on the basis of the lipid content of the tissues. Elimination of the metabolically unaltered compound occurs via the lungs.

Both acute and chronic tetrachloroethylene poisonings have been reported [*2–6*]. Reported symptoms from exposure to an air concentration of less than 400 mg/L include those associated with functional central nervous system (CNS) depression; drowsiness; dizziness; headache; ear, nose, and throat irritation; and stomachache. More severe exposure has produced vomiting, convulsions, coma, and death. No specific treatment for tetrachloroethylene poisoning has been reported, but supportive measures to offset the CNS depression are usually undertaken.

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Case History

A 53-year-old dry cleaner and a co-worker were cleaning and recycling tetrachloroethylene by distillation. Both men were overcome by fumes. Investigators concluded the solvent had been subjected to excessive heat and boiled over or, alternatively, the solvent vapors had exceeded the condensing capacity of the cooling coils. The work space was poorly ventilated. The dry cleaner was dead at the scene. His co-worker recovered without complications after hospitalization.

Autopsy performed 24 h after death revealed a normally developed 170-cm (5-ft, 7-in.), 70-kg (154-lb) male who had superficial thermal burns of the left ear, shoulders, left knee, and left arm where, in a collapsed state, he had been in contact with hot steam pipes. Pulmonary findings consisted of congestion superimposed on mildly fibrotic and diffusely emphysematous lungs with apical bullous emphysema. Diffuse, marked fatty metamorphosis of the liver, moderately severe coronary artery atherosclerosis with focal myofibrillar necrosis, and healed pyelonephritis were present. There were also an old gastrectomy and gastrojejunostomy. Microscopy disclosed no further information. Blood was submitted for analyses in cork-stoppered test tubes containing approximately 45 mg potassium oxalate and 120 mg sodium fluoride and were stored at 4°C until analyzed. Brain, kidney, liver, lung, and gastric contents were submitted in capped, wax-coated, cardboard containers kept at −20°C until analyzed. In addition to the presence of tetrachloroethylene in blood and tissues, an ethanol concentration of 0.20% weight by volume was found in the blood. No other drugs or chemicals were detected.

Experimental Studies

Blood

Blood standards were prepared in the following manner. Known volumes of a 500 mg/L stock solution of redistilled, reagent-grade tetrachloroethylene in ethanol were added to blood not containing tetrachloroethylene. The blood standards were then vortexed for 3 to 4 min. Four blood standards were prepared with tetrachloroethylene concentrations ranging from 1 to 7 mg/L. One-half millilitre of the blood standards was extracted with 50 mL of pesticide-grade hexane with gentle shaking. Two microlitres of the hexane extract were injected into a gas chromatograph equipped with an electron capture detector. The concentration of the tetrachloroethylene in the victim's blood was determined from the resultant standard curve; peak height measurements were used. The coefficient of variation of ten replicate injections of the extract of blood, which contained 4.5 mg/L tetrachloroethylene, was 3.0%.

Tissues

Tissue homogenates were prepared as follows: A weighed portion of tissue (5 to 10 g) was placed in a Sorval® Omni-mixer with nine parts by weight of water and homogenized for 2 to 3 min at room temperature. Tissue standards were prepared by adding known volumes of the 500 mg/L tetrachloroethylene stock solution to similarly homogenized tissues not containing tetrachloroethylene. The homogenates were then vortexed for 3 to 4 min. Four such tissue standards were prepared with the range of tetrachloroethylene concentrations depending on the tissue analyzed. One-half millilitre of the homogenates was extracted with 100-mL portions of hexane with gentle shaking; 2 μL of the hexane extracts were injected into the gas chromatograph. Standard curves, based on peak heights, were used for quantitating the tetrachloroethylene in the victim's tissues.

Instrumentation

The gas chromatograph used was a Hewlett-Packard Model 5730. The glass column used was 0.9 m (3 ft) long with an inside diameter of 2 mm; it contained 10% OV-1 on 80-100 mesh Gas Chrom Q. The carrier gas was 10% methane in argon with a flow rate of 30 mL/min. The oven and injection port temperatures were 100°C while the detector was maintained at 300°C.

The gas chromatograph/mass spectrometer used was a Du Pont Model 21-490B equipped with the Du Pont data system and Varian Model 2700 gas chromatograph. Immediately after injection, the oven was programmed from 60 to 200°C at 20°C/min. The glass column used was 1.25 m by 3 mm inside diameter packed with 3% OV-17 on Gas Chrom Q. Repetitive scans were performed from 600 to 41 AMU at 70 eV and stored in the data system.

Results and Discussion

The identity of tetrachloroethylene was confirmed by gas chromatography/mass spectrometry of a sample of headspace vapor from a portion of lung of the decedent. The comparison was made to the mass spectrum of redistilled, reagent-grade tetrachloroethylene and also to that reported in a spectral library [*7*].

The concentrations of tetrachloroethylene found in the blood and tissues are shown in Table 1.

To assess possible losses of tetrachloroethylene upon storage, blood and brain samples that had been analyzed initially one week after death were reanalyzed five weeks later. Neither the blood, stored in cork-stoppered tubes at 4°C, nor the brain, stored in wax-coated cardboard containers at −20°C, showed measurable loss of tetrachloroethylene.

There is little information in the literature relating blood concentrations to either the amount of exposure or to fatality. Stewart et al [*8*] reported that after a 3-h exposure to about 200 mg/L tetrachloroethylene, the maximum blood level was less than 3 mg/L. Also, an air concentration of 200 mg/L produced light unconsciousness within several minutes in humans, and an air concentration of 600 mg/L proved lethal to mice [*9*]. In another recent study by Lukaszewski [*6*], blood and tissue concentrations in a tetrachloroethylene fatality were reported. Concentrations of tetrachloroethylene, obtained by gas chromatography/mass spectroscopy, were 44 mg/L in blood, 360 mg/L in brain, and 3 mg/L in lung. These concentrations were significantly higher in blood and brain but were lower in lung than those found in the present case. No explanation of these differences is apparent.

Although there is little information on tissue concentrations of tetrachloroethylene in fatalities, there are more data on the tissue levels in deaths resulting from two similar compounds, 1,1,1-trichloroethane and trichloroethylene. Compilations of these data have been tabulated by Baselt [*10*] and Stahl et al [*11*]. In the present case, the relatively low concen-

TABLE 1—*Tetrachloroethylene concentrations in a fatality.*

Autopsy Specimen	Concentration, mg/L[a]
Blood	4.5
Brain	69.0
Kidney	71.0
Liver	240.0
Lung	30.0

[a] For solid tissues, the concentrations are in milligrams per kilogram.

trations of tetrachloroethylene in the lung and the high concentration in the brain were consistent with data derived from the other related compounds. Two irregularities, however, were noted. First, relatively high concentrations of tetrachloroethylene were found in the kidney as compared to those found in the brain; lower kidney/brain ratios of trichloroethane and trichloroethylene were previously observed. The second abnormality was the high concentration of tetrachloroethylene found in the liver. Since the autopsy revealed an extremely fatty liver and since tetrachloroethylene would be expected to distribute according to the lipid content of the tissue, the high liver concentration could be explained on the basis of the higher than normal lipid concentration.

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